LEAD SOIL TREND ANALYSIS
THROUGH SEPTEMBER, 2004
Herculaneum Lead Smelter Site
Herculaneum, Missouri

Tetra Tech EM Inc. (Tetra Tech) was tasked by the U.S. Environmental Protection Agency (EPA) Region 7 Enforcement/Fund Lead Removal program to conduct a trend analysis of soil lead concentrations at selected locations within Herculaneum, Missouri (City). Specifically, the Tetra Tech Superfund Technical Assessment and Response Team (START) 2 was requested to review and analyze data that would enable EPA to determine if soil lead concentrations were increasing over time at a variety of locations within the City. Tetra Tech had previously performed this analysis and was requested to repeat the analysis using the most current sampling data. The assessment was conducted under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and the Superfund Amendments and Reauthorization Act of 1986. The project was assigned under START Contract No. 68-S7-01-41, Task Order No. 0027.

Tetra Tech focused its analysis on one data set called "Recontamination." This data set includes results from a number of residential properties. The data were collected from four different quadrants at each property, and additional data for several properties came from samples collected in driveway areas outside the quadrants. Lead concentrations were estimated at each location at approximately monthly intervals from the time removal activities were completed until September 2004 (sampling round 18). Due to the sequence of removal activities, not all properties underwent the same number of sampling events; the number of events ranged from 4 to 12 events per residence. At many locations, some intervals within the series were omitted because of weather or access restrictions. The lead concentrations were determined by use of a portable X-ray fluorescence (XRF) instrument. Samples were collected and analyzed in accordance with the quality assurance project plan (QAPP) dated September 11, 2001.

This document presents the methods used to evaluate changes in soil lead concentrations following the removal activities, and the results of this analysis.

Methods

Temporal trends in lead concentrations for 24 properties are summarized in Table 1.   Trend tests were conducted for each property using all data collected from round 7 (August 2002) through round 18 (September 2004). The non-parametric Mann-Kendall test was used to evaluate temporal trends for individual properties. The Mann-Kendall test is a widely used statistical test for detecting monotonic trends (that is, trends that are either increasing or decreasing) in time-series of data (Gilbert 1987; Helsel and Hirsch 1992; Gibbons 1994). Because the Mann-Kendall test uses only the relative magnitude of the data rather than their measured values, it has a number of desirable properties: the data need not be normally distributed; and the test is not significantly affected by outliers, missing data, or censored data. Censored data are normally treated in the Mann-Kendall test by setting all non-detect values to a concentration slightly below the minimum detected concentration. However, because this analysis was conducted for pooled measurements from each of the four quadrants for each property, only the median concentrations for each sampling round were considered. Each median value was effectively treated as a detected measurement for the purpose of this analysis. It should be noted that a minimum of four sampling events are required to perform this test, so properties with fewer than four rounds of sampling were not evaluated.

Results

The analysis of temporal trends in lead concentrations identified 14 properties with a statistically significant trend: House Numbers 20, 101, 5, 6, 22, 24, 12, 17, 9, 16, 18, 3, 7, and 8. The trend for each of these properties indicated an increasing soil lead concentrations. House Numbers 20, 101, 5, 6, 22, and 24 are within 0.25 mile of the smelter. House Numbers 12, 17, and 16, are within 0.5 mile of the smelter. House Numbers 9, 18, and 3 are within 0.75 mile of the smelter, and House Numbers 7 and 8 are within 1.0 mile of the smelter. The previous data analysis (June 2004) showed six homes with an increasing trend. Based on the most current results these six homes, in addition to House Numbers 101, 6, 24, 12, 17, 18, 3, and 7, now exhibit a statistically significant increasing trend in lead concentrations.

References:

Gibbons, R. D. 1994. *Statistical Methods for Groundwater Monitoring*. John Wiley & Sons, Inc. New York, New York.

Gilbert, R. O. 1987. *Statistical Methods in Environmental Pollution Monitoring*. John Wiley & Sons, Inc. New York, New York.

Helsel, D. R. and R. M. Hirsh. 1992. *Statistical Methods in Water Resources*. Elsevier. New York, New York.